ISSN: 2581 – 3633

International Journal of Medical Science and Advanced Clinical Research (IJMACR)

Available Online at: https://www.ijmacr.com

Volume – 9, Issue – 6, November – 2026, Page No.: 26 – 36

Gamification in Medical Education: Impact on Student Engagement, Knowledge Retention, and Academic Performance — A Systematic Review

[1]Dr. Uttam Kumar Medisetti, Associate Professor, Department of Forensic Medicine and Toxicology, Rangaraya Medical College, Kakinada, Andhra Pradesh, India.

[2]Dr. Bonthu Mamatha Bharathi, Assistant Professor, Department of General Medicine, Rangaraya Medical College, Kakinada, Andhra Pradesh, India.

Corresponding Author: Dr. Uttam Kumar Medisetti, Associate Professor, Department of Forensic Medicine and Toxicology, Rangaraya Medical College, Kakinada, Andhra Pradesh, India.

How to citation this article: Dr. Uttam Kumar Medisetti, Dr. Bonthu Mamatha Bharathi, "Association of High Maternal Body Mass Index with Feto-Maternal Outcomes: An Observational Study", IJMACR– November – 2026, Volume – 9, Issue – 6, P. No. 26 – 36.

Open Access Article: © 2026, Dr. Uttam Kumar Medisetti, et al. This is an open access journal and article distributed under the terms of the creative common's attribution license (http://creativecommons.org/licenses/by/4.0). Which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

Type of Publication: Review Article

Conflicts of Interest: Nil

Abstract

Background: Gamification incorporates game-design elements such as immediate feedback, scoring, narrative challenges, progress indicators and leaderboards into teaching. Its effect on medical students' engagement may differ from its effects on delayed knowledge retention and independently assessed academic performance.

Objective: To examine how gamified educational interventions influence participation, learner engagement, knowledge acquisition and retention, examination performance and clinical skills in undergraduate and postgraduate medical education.

Methods: Primary research involving undergraduate and postgraduate medical trainees was evaluated by intervention, comparator, outcome, study design and follow-up. Engagement, immediate learning, delayed retention, examinations and clinical competence were analysed separately. Of 1,504 records identified, 1,236 underwent title and abstract screening, 80 full texts were assessed and 10 studies were included. Heterogeneous intervention designs and outcome measures were synthesised narratively.

Results: A pharmacology quasi-experiment reported post-test means of 8.47 (SD 1.30) in game sessions and 6.90 (SD 2.02) in controls (P = .006 for the game group's pre–post improvement). A randomized diabetes board-game trial included 56 students and found within-group gains in both arms. A pediatric-resident randomized trial completed by 73 learners found no additional knowledge or skills benefit from Kahoot despite favorable learner attitudes. A randomized

dermatology leaderboard trial found 3.3-fold higher case-training volume without a significant improvement in diagnostic score (P = .40). Evidence from larger syntheses similarly shows heterogeneous effects and limited follow-up for retention.

Conclusions: Gamification can support participation, formative practice and perceived enjoyment. Improvement in delayed knowledge retention and high-stakes academic performance is less consistent and depends on the intervention, comparator and assessment method. Rigorous longer-term trials are needed.

Keywords: Gamification, Medical Students, Educational Games, Learner Engagement, Spaced Retrieval, Knowledge Retention, Academic Performance, Serious Games

Introduction

The expansion of digital teaching, large medical curricula and the need for frequent formative assessment have increased interest in active learning. Gamification denotes the use of game elements within otherwise non-game activities, whereas serious games provide an entire purpose-built game environment. These approaches overlap in practice but should not be treated as identical interventions.[1-3]

Immediate feedback, repeated retrieval, voluntary practice and social interaction may improve learning opportunities. However, high login counts, favorable satisfaction scores and total questions attempted are engagement proxies—not proof of durable knowledge gain. Conversely, better immediate test scores may reflect repetition of identical items rather than transfer to unseen clinical problems. These distinctions are essential when evaluating educational value[1,4,5].

This review addresses three outcomes: (i) behavioral and perceived engagement; (ii) short-term acquisition and objectively measured delayed retention; and (iii) examination achievement, clinical reasoning and competence. It also considers whether competitive elements have differential effects according to learner preference and training level.

Methods

Review design, objectives and eligibility criteria

This review addressed whether gamification improves (1) behavioral participation and learner-reported engagement, (2) immediate knowledge acquisition, (3) delayed retention assessed after the intervention, and (4) academic achievement, diagnostic reasoning or clinical skills. Eligible participants were undergraduate medical students, interns, residents and other physician trainees. Gamification was defined as adding scores, competition, rankings, badges, goals, feedback or progression to learning; full serious games were considered separately where applicable. Comparators were nongamified instruction, equivalent question practice, routine curricula, or preintervention/historical groups. Experimental, quasi-experimental, cohort and before–after reports with at least one relevant outcome were eligible. Reviews, editorials, nonmedical trainee populations, duplicate cohorts and studies without extractable educational outcomes were excluded from primary-study synthesis.

Information sources and search strategy

Search terms combined gamification concepts (gamif*, serious game*, game-based learn*, escape room*, Kahoot, quiz platform*, leaderboard*) with medical education (medical student*, medical school, resident*, clerkship, physician trainee*) and outcomes (engagement, motivation, knowledge, recall, retention, academic achievement, examination, clinical reasoning, procedural skill). Information sources included

PubMed/MEDLINE, Scopus, Web of Science, Embase, reference lists and publisher records. Publications available through June 2026 were eligible[4,5].

Ten primary studies were included in the qualitative synthesis. Additional publications informed contextual and methodological interpretation and were not counted as primary studies. Outcomes were summarised in their original units (mean ± SD, percentages, correlation coefficients, P values and standardized effects). Meta-analysis was not undertaken because interventions, comparators, assessment instruments and follow-up intervals differed. Previously published synthesis estimates were discussed separately[1,2,5-7].

Study selection and data management

Identification, deduplication, title and abstract screening, full-text assessment and inclusion were organised into sequential selection stages. Of 1,504 records identified, 268 duplicate records were removed; 1,156 records were excluded at screening and 70 full-text reports were excluded after eligibility assessment. The resulting qualitative synthesis comprised 10 studies (Figure 1).

Data items and outcome definitions

Extraction fields comprised author/year, setting and learner level, design, analytic sample, allocation, gamification components, duration, comparison condition, timing of assessments, assessment tool and reported estimate. Engagement was separated into behavioral activity (attendance, logins and cases completed) and student perceptions (motivation, satisfaction). Immediate knowledge was defined as an assessment close to teaching; delayed retention as reassessment after a stated interval. Course grades, independent test scores, clinical reasoning and procedural performance were not treated as equivalent outcomes.

Risk-of-bias domains and certainty considerations

Risk-of-bias considerations included random-sequence generation, allocation concealment, baseline comparability, differences in practice time or instructor contact, missing outcome data, selective reporting, self-selection and historical cohort effects. Blinding of learners was generally impractical, increasing the importance of objective assessment and blinded marking. Evidence interpretation accounted for selection bias, inconsistency, indirectness and imprecision. Formal ROB 2, ROBINS-I and GRADE classifications were not assigned.

Effect measures and synthesis approach

Between-group effects were prioritized over within-group gains for comparisons of educational effectiveness. Reported means, standard deviations, ratios, frequencies, correlations and significance tests were retained without deriving missing standard errors or inventing effect sizes. Randomized trials were interpreted separately from before–after or historical comparisons; studies reporting only satisfaction or participation were not used as proof of improved examination performance. Thematic synthesis was organized by engagement, immediate knowledge, delayed retention, academic outcomes and clinical skill; no subgroup meta-regression or publication-bias test was conducted.

Results

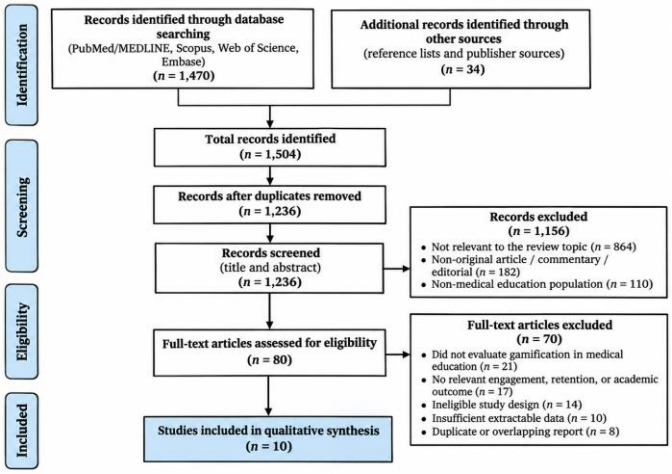
Study selection

Database searches identified 1,470 records, with 34 additional records from other sources, yielding 1,504 records. After removal of 268 duplicates, 1,236 records underwent title and abstract screening; 1,156 were excluded (864 unrelated to the topic, 182 non-original publications and 110 involving nonmedical populations).

©2026, IJMACR

Full texts were assessed for 80 reports, of which 70 were excluded (21 without relevant gamification, 17 without eligible outcomes, 14 ineligible study designs, 10 with insufficient extractable data and 8 duplicate or overlapping reports). Ten studies were included in the qualitative synthesis (Figure 1).

Figure 1. PRISMA Flow Diagram of Study Selection



Overview of included study designs and settings

The ten studies listed in Table 1 encompassed undergraduate preclinical courses, clerkship teaching and postgraduate resident training. They used digital response systems, question-bank incentives, leaderboards, board games and curriculum-based tasks. Randomized comparisons were available for diabetes instruction, pediatric musculoskeletal learning and dermatology diagnosis[8,10,12]; other reports used nonrandom, prospective, course-based or historical comparisons[9,11,13,15–17]. The units of analysis varied between individual learners, course sessions, completed cases and repeated questions. Consequently, raw counts such as 34,556 cases cannot be interpreted as 34,556 independent students.

Interventions and outcome measures

Gamified interventions differed substantially. Some studies added speeded-response questions to otherwise unchanged curricula; others altered content delivery, practice frequency, peer interaction and feedback simultaneously. Accordingly, a favorable result for a bundled intervention does not isolate the effect of points or competition alone. Table 1 summarizes major studies with extractable quantitative results.

Table 1: Selected primary studies of gamification in medical education

Study	Design / learners	Intervention and comparator	Relevant reported result
Shadan et al., 2025 [8]	RCT; 56 preclinical medical students	Diabetes board game vs equivalent self-study	Both groups improved (within-group P < .001); favorable response patterns with game
Pharmacology games, 2025 [9]	Quasi-experiment; 40 analyzed students, 79 course-sessions	Cross DRUGs / escape games vs lecture slides	Post-test 8.47 ± 1.30 vs 6.90 ± 2.02; self-selection
Pediatric MSK curriculum, 2022 [10]	RCT; 73/85 residents completed	Kahoot vs paper questions	Both arms improved; no between-arm improvement difference
Medical-school question bank, 2025 [11]	Course-based observational study	Gamified formative question bank	97% participation; mean 79.8% accuracy; grade correlation R = .30
Dermatology leaderboard, 2026 [12]	RCT; 71 learners	Leaderboard vs same diagnostic training without leaderboard	3.3-fold more cases; skill gain comparison P = .40

Radiation oncology, 2025 [13]	Historical cohorts; 176 controls, 166 intervention	Kahoot + TikTok alongside conventional teaching	Bundled intervention; intervention attribution limited
Primary care serious game, 2019 [14]	RCT; 27 medical students	Serious game vs text-based material	Small randomized educational comparison
Foundational sciences daily game, 2026 [15]	Quasi-experiment; 445 participating students	Repeated biochemistry/genetics games	Positive reception; no clear course-grade relationship
Obstetrics clerkship game, 2026 [16]	Comparative clerkship groups	Paper progress/task gamification	Written scores 85.0 ± 5.9 vs 78.2 ± 6.8
Anatomy teaching, 2026 [17]	Four academic cohorts, 2020–2024	Gamification plus standard anatomy vs standard	Higher final grades in gamified cohorts (P < .005)

Intervention comparators and follow-up

Intervention intensity and comparator equivalence differed between studies. The randomized dermatology study compared a leaderboard with otherwise similar case-based training[12], providing a relatively direct test of competitive incentive. The pediatric residency comparison contrasted Kahoot with paper-based questioning[10]. In several quasi-experiments, games also increased interaction, practice opportunity or content variety, so any score difference may reflect the full learning package rather than game design alone[9,13,16]. Assessment largely occurred immediately after exposure; independently assessed retention months later was uncommon.

Engagement and motivational outcomes

Behavioral engagement frequently increased. A gamified medical science question bank recorded participation by 97% of students and mean answer accuracy of 79.8%; participation and course achievement were correlated (R = .30, P < .001), although motivated or better-prepared students may preferentially engage[11]. In a pharmacology intervention, 25 of 30 respondents (83%) described the games as enjoyable, 24 of 30 (80%) perceived conceptual benefit and 21 of 30 (70%) favored learning through the format[9]. These outcomes establish acceptability, not an independent causal examination benefit.

A leaderboard randomized trial provides a particularly informative contrast. Among 71 learners completing 34,556 dermatology case assessments, the leaderboard arm practiced approximately 785 cases per student versus 240 in the control arm (a 3.3-fold difference, P < .01), yet did not outperform controls on diagnostic-skill improvement (P = .40)[12]. The finding separates increased practice volume from demonstrated competence. A two-year foundational-science game evaluation involving 445 medical students likewise reported favorable participation but did not demonstrate a clear association between game involvement and improved course-grade differences[15].

Knowledge acquisition and short-term performance

The pharmacology quasi-experiment enrolled 72 students, with 49 consenting and 40 contributing complete paired assessments. The game sessions produced a mean post-test score of 8.47 (SD 1.30), compared with 6.90 (SD 2.02) in nongame sessions. However, session-level participation was nonrandom, participants could contribute to multiple conditions, and improvement was tested within groups; the difference

cannot be interpreted as an unbiased randomized treatment effect[9].

In the "Diabe-teach" randomized trial, 56 preclinical students received identical diabetes instructional material and were assigned to a board-game or conventional self-study group. Both arms improved their immediate test scores (P < .001), and the game condition demonstrated favorable patterns of correct answers and uncertainty recognition[8]. A 2026 obstetrics-clerkship comparison found higher written scores in the gamified cohort (85.0 ± 5.9 versus 78.2 ± 6.8) alongside higher task completion and self-reported satisfaction; the study design limits separation of the game effect from differences in learner effort or teaching context.[16]

In contrast, a randomized musculoskeletal curriculum involving pediatric residents (73/85 completers) found improvements in knowledge and physical examination skills in both Kahoot and paper-question groups but no additional between-arm educational benefit from gamification[10]. This null comparison is important because content and formative practice were held more similar across groups than in many bundled educational interventions.

Knowledge retention and academic achievement

Delayed retention was less consistently measured than immediate post-test performance. A digital game for graduate medical education recorded 16,427 completed questions, with accuracy on 1,046 repeated question pairs improving by 11.9 percentage points (P < .0001); such repeated-response changes can reflect retrieval practice and re-exposure rather than a separately randomized effect of game design[18]. Long-term unseen-item testing, transfer to clinical decisions and retention after course completion remain uncommon.

The radiation oncology historical-cohort investigation compared 176 learners receiving a conventional curriculum with 166 receiving additional Kahoot and TikTok activities[13]. Because two educational components were introduced together across successive cohorts, a gain cannot be ascribed uniquely to the game system. In an anatomy investigation across four academic years, gamified cohorts achieved higher final grades (P < .005), but cohort-level contrasts may reflect secular influences[17]. Table 2 separates the evidentiary strength across outcomes.

Table 2: Interpretation by learning domain

Outcome	Strongest observation	Key validity concern
Engagement / use	97% participation [11]; 3.3-fold increase in case practice [12]	Novelty, incentives and self-selection
Learner satisfaction	83% reported enjoyment in pharmacology respondent survey [9]	Self-report and response bias
Immediate knowledge	Post-test 8.47 vs 6.90 in game/control sessions [9]	Nonrandom session choice and repeated participation
Delayed retention	11.9-percentage-point repeated-item gain in resident game [18]	Repeated items rather than unseen delayed testing
Written examinations	85.0 vs 78.2 in obstetrics clerkship [16]	Nonrandom curricula and assessment comparability
Clinical competence	No incremental Kahoot benefit in pediatric RCT [10]; no skill effect in dermatology RCT [12]	Variable tasks, intervention intensity and sample sizes

©2026, IJMACR

Risk of bias across the evidence

Randomized studies offer stronger protection against measured and unmeasured baseline differences, but small groups, unblinded assessment and incomplete follow-up can still bias results. The pediatric trial had 73 of 85 residents complete follow-up[10]. For the pharmacology quasi-experiment, only 40 learners contributed complete paired data from 72 approached or enrolled students, and the game versus nongame exposure was not randomly assigned.[9] Historical cohort comparisons in radiation oncology and anatomy were particularly sensitive to changes in curricular content and cohort composition[13,17]. Self-selected question-bank use and satisfaction surveys are vulnerable to baseline motivation and response bias[9,11,15]. These limitations are considered when interpreting outcome direction, not converted into numerical risk-of-bias scores.

Certainty, inconsistency and missing outcome domains

The direction of evidence was most consistent for participation and volume of educational activity, but findings for knowledge and academic scores varied by study design. Two randomized comparisons did not show an incremental improvement in a relevant performance outcome despite increases in engagement or favorable learner ratings[10,12]. Objective long-term retention, unprompted clinical transfer, patient-relevant endpoints and adverse effects of competition were rarely reported. No included study set supported a reliable pooled effect across all three domains of engagement, knowledge retention and academic performance.

Reporting biases and sensitivity of interpretation

Selective publishing of positive educational innovations is plausible; however, formal funnel-plot or small-study-effects tests would be inappropriate without comparable effect sizes from an adequately large set of studies. The findings are interpreted cautiously when only within-group P values are available, when identical questions are repeated at follow-up, or when users self-select practice frequency. Contextual meta-analyses are discussed below but their primary trials may overlap with the reports summarized in Table 1.

Context from published systematic reviews and meta-analyses

A foundational systematic review of health professions gamification identified 44 included empirical studies from 5,044 identified records; it documented wide variation in game mechanics, outcomes and theoretical justification[1]. A serious-games meta-analysis identified 37 randomized trials, pooled 29, and found no clear advantage in knowledge acquisition (standardized mean difference [SMD] 0.16; 95% CI −0.20 to 0.52), cognitive skill (SMD 0.08; 95% CI −0.73 to 0.89) or procedural skill (SMD 0.05; 95% CI −0.78 to 0.87), although confidence in skills showed a small gain (SMD 0.27; 95% CI 0.01 to 0.53)[2].

A 2026 meta-analysis targeting clinical reasoning across medical and allied health education reported 26 included studies, with 10 available for quantitative pooling; the pooled SMD was 1.11 (95% CI 0.69–1.52; I^2 = 85%), and the authors judged certainty low[6]. A Bayesian network review including 31 randomized trials (3,439 learners) reported imprecise comparative estimates, including Kahoot-based knowledge benefit MD 9.1 on a 0–100 scale (95% credible interval −8.9 to 27), compatible with no benefit.[7] These syntheses answer different questions and cannot be combined as if they represented independent learner populations.

Related published studies address delirium education[26], serious games for patient-safety training.[27] chatbot-based

©2026, IJMACR

clinical learning[28], diagnostic decision-making[38], learner satisfaction[39], and game-based assessment versus multiple-choice formats[38]. These reports expand the contextual evidence but are not added to the ten-study primary synthesis. Design publications on escape-room implementation and gamification mechanisms inform intervention reporting and replication[34-37,40].

Discussion

Principal findings

The strongest and most consistent outcome is willingness to participate. Gamified interfaces can prompt retrieval, lower barriers to repeated practice and offer timely feedback, but stronger engagement is not inherently equivalent to higher independent examination or clinical performance. Controlled null findings in pediatric residency and randomized dermatology training show why engagement and educational effectiveness must remain separate endpoints[10,12].

Mechanisms and intervention design

Gamification may enhance learning when it increases spaced retrieval, immediate explanatory feedback, progressive difficulty and opportunities to correct errors. These mechanisms differ from competition alone. Leaderboards may motivate repeated interaction but can also incentivize speed and volume over reflective reasoning. Feedback quality, item diversity and curricular alignment may therefore matter more than point allocation[1,3,12,19].

Additional controlled evidence distinguishes game mechanics from clinical learning. In a randomized trial involving 105 medical students, preparation with an advanced-life-support smartphone game improved algorithm post-test scores (17.22 ± 1.93 versus 16.60 ± 1.97; P = .01)[29]. An app-based chest-tube training trial reported higher observed procedural performance (38.0 versus 30.5 points; P < .001) [30], whereas a serious game for pediatric clinical management improved simulated-case performance relative to a low-stimulus control but not to an adaptive tutorial[31]. A randomized cross-over investigation found no clear gain in risk competence and raised concerns about competition as a motivational mechanism[25].

Smaller implementation studies illustrate the variety of outcomes captured by educational games. In an emergency-medicine virtual escape-box evaluation, 134 participating students reported high engagement, although findings centered on learner ratings rather than blinded competency measures[23]. A peer-led physiology escape-room study reported higher examination scores among participants than nonparticipants, but selection and baseline differences limit causal interpretation[24]. An interdisciplinary escape-room evaluation found a between-group difference in retention at one month ($F(1,32) = 12.59$; $P = .001$) despite no clear difference in immediate knowledge gain [33]. Reviews of game-design elements and SOLO-taxonomy levels emphasize the limited evidence linking individual game features with advanced learning outcomes[21,22].

Implications for assessment and curriculum

For high-stakes medical education, future evaluations should report a prespecified primary outcome, validated assessments, baseline ability, independent delayed testing, individual and cluster allocation procedures and attrition. If conventional teaching and gamified teaching differ in practice time or faculty contact, these differences should be measured rather than attributed entirely to the game layer. Educators should also monitor accessibility, technological burden and anxiety arising from public ranking[4,5,20].

Limitations of the evidence

The studies used heterogeneous intervention packages and measures, and many combined educational games with additional retrieval practice, staff contact or new material. Self-reported motivation and repeated-question gains were not equivalent to unseen-item retention or clinical performance. Observational and historical comparisons were vulnerable to self-selection, secular curriculum changes and baseline ability differences. Follow-up intervals were generally short; several studies lacked independently assessed clinical outcomes. These limitations constrain causal attribution and cross-study generalization.

Conclusion

Gamification is a useful supplement to medical teaching for formative engagement and repeated practice. Evidence for increased learner enjoyment and activity is stronger than evidence for sustained retention, examination achievement or transferable clinical skill. Effective implementation should prioritize well-designed feedback, retrieval practice and explicit learning goals, while future trials should establish effects using matched comparators and delayed independent assessments.

References

1. Van Gaalen AEJ, Brouwer J, Schönrock-Adema J, Bouwkamp-Timmer T, Jaarsma ADC, Georgiadis JR. Gamification of health professions education: a systematic review. Adv Health Sci Educ Theory Pract. 2021;26:683–711. doi:10.1007/s10459-020-10000-3.
2. Maheu-Cadotte MA, et al. Efficacy of serious games in healthcare professions education: a systematic review and meta-analysis. Simul Healthc. 2021. PMID:33196609.
3. Khazaei MR, Hosseini MA, Ramezani G. Gamification in medical sciences education: a scoping review. Recenti Prog Med. 2025;116:291–301. doi:10.1701/4495.44949.
4. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71. doi:10.1136/bmj.n71.
5. Campbell M, McKenzie JE, Sowden A, et al. Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline. BMJ. 2020;368:l6890. doi:10.1136/bmj.l6890.
6. Lee CY, Lee CH, Lai HY, et al. Do games work? A meta-analytic synthesis of gamified learning for clinical reasoning in medical and allied health education. Med Educ Online. 2026; 31:2614233. doi:10.1080/10872981.2026.2614233.
7. Comparative effectiveness of game-based learning modalities in nursing and medical education: a systematic review and Bayesian network meta-analysis. 2026. PubMed PMID:42424836.
8. Shadan M, Ismail H, Naushad FHM. Diabe-teach: a randomized controlled trial of a gamified approach to enhance medical undergraduates' knowledge and comprehension of diabetes mellitus. BMC Med Educ. 2025; 25:17. doi:10.1186/s12909-024-06602-9.
9. Open-access web-based gamification in pharmacology education for medical students: quasi-experimental study. 2025. PubMed PMID:41348914.
10. The impact of a gamified curriculum using Kahoot! on musculoskeletal knowledge and skill acquisition among pediatric residents. 2022. PubMed PMID:35172199.

©2026, IJMACR

11. A gamified formative question bank to enhance student learning and engagement in a foundational medical science course. Anat Sci Educ. 2026;19:891–901. doi:10.1002/ase.70107.
12. Gamification of dermatology diagnostics training: a nationwide, randomized, controlled trial of 34,556 cases. 2026. PubMed PMID:42752589.
13. Zapata-Martínez I, et al. Radiation oncology active learning in undergraduate medical education: the usefulness of Kahoot and TikTok. J Cancer Educ. 2025; 40:847–853. doi:10.1007/s13187-025-02583-5.
14. Tubelo RA, et al. Serious game is an effective learning method for primary health care education of medical students: a randomized controlled trial. Int J Med Inform. 2019; 130:103944. doi: 10.1016/j.ijmedinf.2019.08.004.
15. Outcomes of a foundational sciences daily engagement game in medical education. 2026. PubMed PMID:42204775.
16. Paper-based gamification to enhance competency-based education in an obstetrics clerkship. 2026. PubMed PMID:42298486.
17. The influence of gamification on the teaching assessment of human anatomy. 2026. PubMed PMID:42382816.
18. Gamification as a tool for enhancing graduate medical education. 2014. PubMed PMID:25352673.
19. Karimian Z, Momeni M, Zarifsanaiey N. Enhancing radiographic interpretation: effects of gamification on medical students' knowledge, skills, and satisfaction—a quasi-experimental study. BMC Med Educ. 2025;25:958. doi:10.1186/s12909-025-07523-x.
20. Punja D, Tomar A. A quasi-experimental crossover study on student engagement and performance in a gamified team-based learning module in physiology. Med Educ Online. 2026;31:2715862. doi:10.1080/10872981.2026.2715862.
21. Aster A, Laupichler MC, Zimmer S, Raupach T. Game design elements of serious games in the education of medical and healthcare professions: a mixed-methods systematic review of underlying theories and teaching effectiveness. Adv Health Sci Educ Theory Pract. 2024;29:1825–1848. doi:10.1007/s10459-024-10327-1.
22. Huang WD, Loid V, Sung JS. Reflecting on gamified learning in medical education: a systematic literature review grounded in the Structure of Observed Learning Outcomes (SOLO) taxonomy 2012–2022. BMC Med Educ. 2024;24:20. doi:10.1186/s12909-023-04955-1.
23. Cantwell C, Saadat S, Sakaria S, Wiechmann W, Sudario G. Escape box and puzzle design as educational methods for engagement and satisfaction of medical student learners in emergency medicine: survey study. BMC Med Educ. 2022;22:518. doi:10.1186/s12909-022-03585-3.
24. Carrasco-Gomez A, et al. Impact of a peer-to-peer escape room activity in the learning of Human Physiology of medical students from the University of Málaga. Front Physiol. 2023. PMID:37711460.
25. Kirsch J, Spreckelsen C. Caution with competitive gamification in medical education: unexpected results of a randomised cross-over study. BMC Med Educ. 2023;23:259. doi:10.1186/s12909-023-04258-5.
26. Buijs-Spanjers KR, Hegge HHM, Jansen CJ, Hoogendoorn E, de Rooij SE. A web-based serious

©2026, IJMACR

game on delirium as an educational intervention for medical students: randomized controlled trial. JMIR Serious Games. 2018;6: e17. doi:10.2196/games.9886.

27. Comparative effectiveness of a serious game and an e-module to support patient safety knowledge and awareness. PubMed PMID:28148296.
28. Chatbot-based serious games: a useful tool for training medical students? A randomized controlled trial. PubMed PMID:36913346.
29. Precourse preparation using a serious smartphone game on advanced life support knowledge and skills: randomized controlled trial. PubMed PMID:32149711.
30. Haubruck P, Nickel F, Ober J, et al. Evaluation of app-based serious gaming as a training method in teaching chest tube insertion to medical students: randomized controlled trial. J Med Internet Res. 2018;20: e195. doi:10.2196/jmir.9956.
31. Are serious games seriously good at preparing students for clinical practice? A randomized controlled trial. PubMed PMID:38460191.
32. Ishizuka K, Shikino K, Kasai H, et al. The influence of gamification on medical students' diagnostic decision making and awareness of medical cost: a mixed-method study. BMC Med Educ. 2023; 23:813. doi:10.1186/s12909-023-04808-x.
33. Game-based medical education: learning effects of an interdisciplinary and interprofessional escape room. Med Sci Educ. 2026. doi:10.1007/s40670-026-02661-3.
34. Game-based learning in undergraduate medical education: evaluation of an interdisciplinary escape room. PubMed PMID:41241744.
35. Bakkum MJ, Richir MC, Sultan R, et al. Can students create their own educational escape room? Lessons learned from the opioid crisis escape room. Med Sci Educ. 2021; 31:1739–1745. doi:10.1007/s40670-021-01425-5.
36. Rutledge C, et al. Gamification in action: theoretical and practical considerations for medical educators. Acad Med. 2018; 93:1014–1020. PubMed PMID:29465450.
37. Design and implementation of two medical escape rooms: an educational case study. PubMed PMID:37102471.
38. Medical student evaluation with a serious game compared to multiple choice questions assessment. PubMed PMID:28512082.
39. Assessing medical student satisfaction and interest with serious game. PubMed PMID:35288906.
40. Gamification with progress bars improves performance and retention in virtual reality simulation: a randomized, controlled trial. PubMed PMID:42715416.

©2026, IJMACR